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MONTHLY STATUS LETTER NO. 3

DEVELOPMENT OF LOW NOISE TRAVELING-WAVE TUBES
Phase III. : Environmentalization

This report Covers the Period 9 April 1962 to 9 May 1962

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NOTICE

ABSTRACT

The preliminary designs for the improved M2108 and M2110 packages have been completed and the parts are being fabricated. The new designs provide for O-ring seals at all potential leakage points, and are of a more rugged mechanical design.

The program is behind schedule due to a delay in the M2108 environmentalization. This delay is due, in part, to a delay in obtaining the M2108 humidity and salt spray data, and due to a redesign of the M2108 package that is more extensive than originally planned. This, in turn, caused a delay in fabrication of the new package parts.

Additional environmental test data taken during a previous reporting period are presented.

The program for the next reporting period is outlined.

CONTENTS

ILLUSTRATIONS

1. PURPOSE

1.1 The purpose of this phase of NObsr-81227 is to environmentalize, in accordance with Class 2 requirements of MIL-E-5400E(ASG), the tubes developed under the previous phases of this contract.

1.2 The detailed objectives of this contract are the following.

1.2.1 Environmentalize tubes in order to operate under the following conditions.

Shock: 15 g
Temperature: -54C to 71C
Altitude: 70,000 feet
Vibration: 5 to 55 cps, 0.06 double amplitude

1.2.2 Perform evaluations on two tubes each of X-, C-, S-, and L-bands, as follows.

Complete environmental tests
Temperature
Shock
Vibration
Life test to 1000 hours minimum

1.2.3 Present electrical, mechanical, and environmental specifications in MIL-E-1 format for each of X-, C-, S-, and L-bands for reliable performance in military electronic systems.

1.2.4 Deliver two each of X-, C-, S-, and L-band tubes which meet the objective specifications under this phase (III) of the contract, and which also meet the original objective specifications of the contract.

2. PROGRESS DURING THE REPORTING PERIOD

2.1 Effort during the reporting period has been directed toward evaluation of environmental test data taken during previous periods, toward environmentalization of the M2108 and the M2110, toward completion of the mechanical and electrical test forms, and toward final evaluation of the solution of the interelectrode leakage problem.

2.2 Environmental Tests

2.2.1 The humidity and salt spray tests, scheduled for completion during this reporting period, were not started. The delay is due to the inability to use any of the vacuum envelopes or packages which had been set aside for these tests. New components are expected to be available during the next period.

2.2.2 Additional results of the environmental tests which had been run during the previous reporting periods on the production versions of the M2108 (M2105), M2109 (M2212), and M2110 (M2103) are presented in Figs. 1 through 5.

2.2.2.1 The data in Figs. 1 through 5 are representative of the data taken for the tubes which have successfully passed the environmental tests.

2.2.2.2 Some "failures" have occurred during vibration tests: M2105, Serial 222; M2112, Serial 87; and M2103, Serial 71. All failed during vibration; however, it should be noted that these failures occurred at vibrational frequencies outside the range of this contract.

2.3 M2108 Package Environmentalization

2.3.1 The M2108 package has been redesigned in order to overcome the potentially weak points of the existing M2108 package.

2.3.1.1 Lack of adequate sealing against humidity and salt spray appears to be the weakest point in the present M2108 design. (This is true also for the M2109, M2110, and M2115.)

2.3.1.2 The M2108 package has been redesigned in order to provide O-ring seals at all potential leakage points.

2.3.1.3 This phase of the program is slightly behind schedule because drawings into the machine shop, and parts delivery from the machine shop, were delayed. This delay was caused by a more extensive redesign of the M2108 package than originally had been planned. The additional redesign was instituted to make the package more mechanically rugged and to facilitate fabrication of the package.

2.4 M2110 Package Environmentalization

2.4.1 The M2110 has been redesigned (as part of MEC program 323) to use pin matches. As part of the design change, the package has been modified to use 5/8 inch OD Alnico VIII magnets. The outer capsule has been changed to be 1.5 inch OD over its whole length (except for mounting blocks). All possible leakage points have been O-ring sealed.

2.5 Mechanical and Electrical Test Forms

2.5.1 Work has been started on the mechanical and electrical test forms. A preliminary format has been established and is now being evaluated.

2.6 Build Ten M2108 Tubes

2.6.1 Work on this part of the program has not progressed as well as anticipated due to slippage in the environmentalization of the M2108 package.

2.7 M2108 Life Test

2.7.1 The M2108 life test is performing well with only small changes in noise figure, saturated power output, and small-signal gain. The life test is scheduled to reach 1,000 hours on 21 May 1962.

2.8 Interelectrode Leakage

2.8.1 The modification of the grid structures in the MEC low noise TWT's (monthly status letter No. 2 on Phase III of subject contract) has been demonstrated during the reporting period to be successful in preventing deposition of barium on the anode-1-to-grid insulation. The diodes used during the test program were broken apart between anode 1 and the grid, and then a sensitive test for the presence of barium was performed.

2.8.1.1 The surface of the insulators which came from the guns using the modified grids showed no traces of barium.

2.8.1.2 The surface of all the insulators which came from the guns that had failed due to interelectrode leakage showed large amounts of barium opposite the pump-out holes in the grid.

3. OPERATIONAL RESULTS

3.1 Environmental Tests

3.1.1 The data presented in Figs. 1 through 5 are from the environmental tests performed during the previous reporting periods. Noise figure performance shows some degradation at temperatures below -40C (Fig. 1, 4, and 5), but in general, this has not proven to be a problem.

3.1.2 M2105, Serial 222, M2112, Serial 87, and M2103, Serial 71 all "failed" during vibration. The M2105 and the M2112 failures were directly ascribable to assembly operator error and were repairable. The failure of the M2103 was not as clear cut.

3.1.2.1 During vibration of M2103, Serial 71, a package resonance was found at 697 cps on all axes, and there was signal amplitude modulation of greater than 1 db at 936 cps. Examination of the tube revealed nothing, and vibration was restarted. The tube was vibrated at the 10 g level for about 30 minutes. The vibration was discontinued when the power output became highly erratic.

3.1.2.2 X-rays of the tube revealed no damage, but a measurement of the input VSWR indicated that something had changed in the input match. The tube was taken apart, and it was found that the trouble was within the vacuum envelope.

3.1.2.3 Microscopic examination of X-rays of the vacuum envelope revealed that the problem was caused by the breakage of the connection between the helix and the helix dc lead. Analysis of this failure has led to a redesign of the helix dc lead, which will be evaluated during the next reporting period.

ENVIRONMENTAL TEST DATA
M2105, Serial 87

1. TEMPERATURE AND ALTITUDE*

Test	Temperature			
	Ambient	-60C	60C	Ambient
Helix Current (μa)	96	160	160	97
Noise Figure (db)	9.6	13.3	13.0	9.5
Small-Signal Gain (db)	37.0	37.5	35.0	38.5
Saturated Power Out (dbm)	15.0	15.0	14.0	15.2
Altitude (ft)	50,000	50,000	50,000	50,000

* Data taken for operation at 9.0 Gc.

2. VIBRATION

3-Axes, Operating		
5-63 cps	0.050 inch, DA	AM less than 0.5 db
63-2000 cps	10 g	AM less than 0.5 db

3. SHOCK

3-Axes, Nonoperating		
20 g	11 ± 1 milliseconds	OK

Fig. 1.1 Environmental Test Data, M2105, Serial 87.

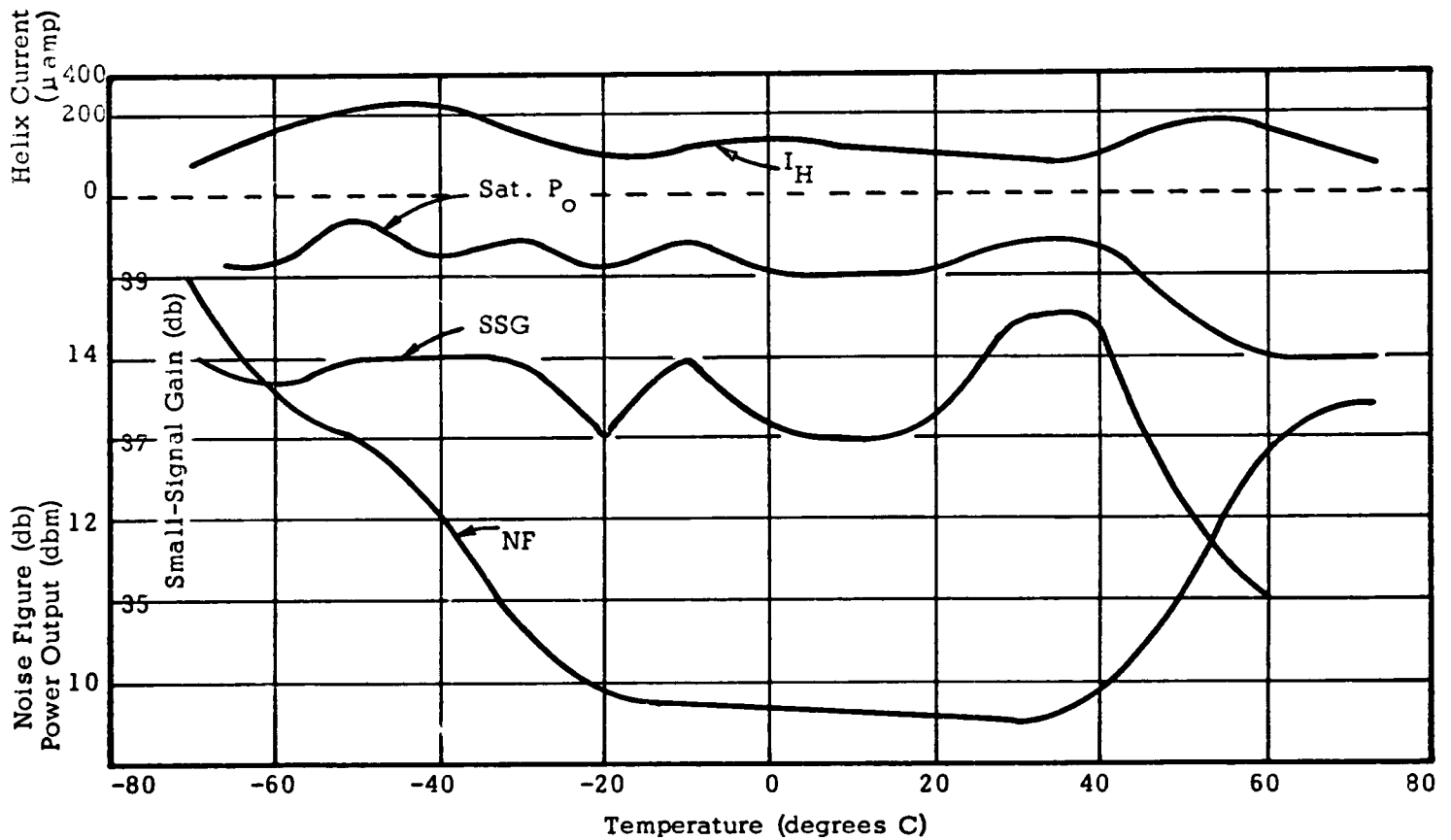

Fig. 1.2 Temperature Test Performance, M2105, Serial 87.
(Frequency = 9.0 Gc)

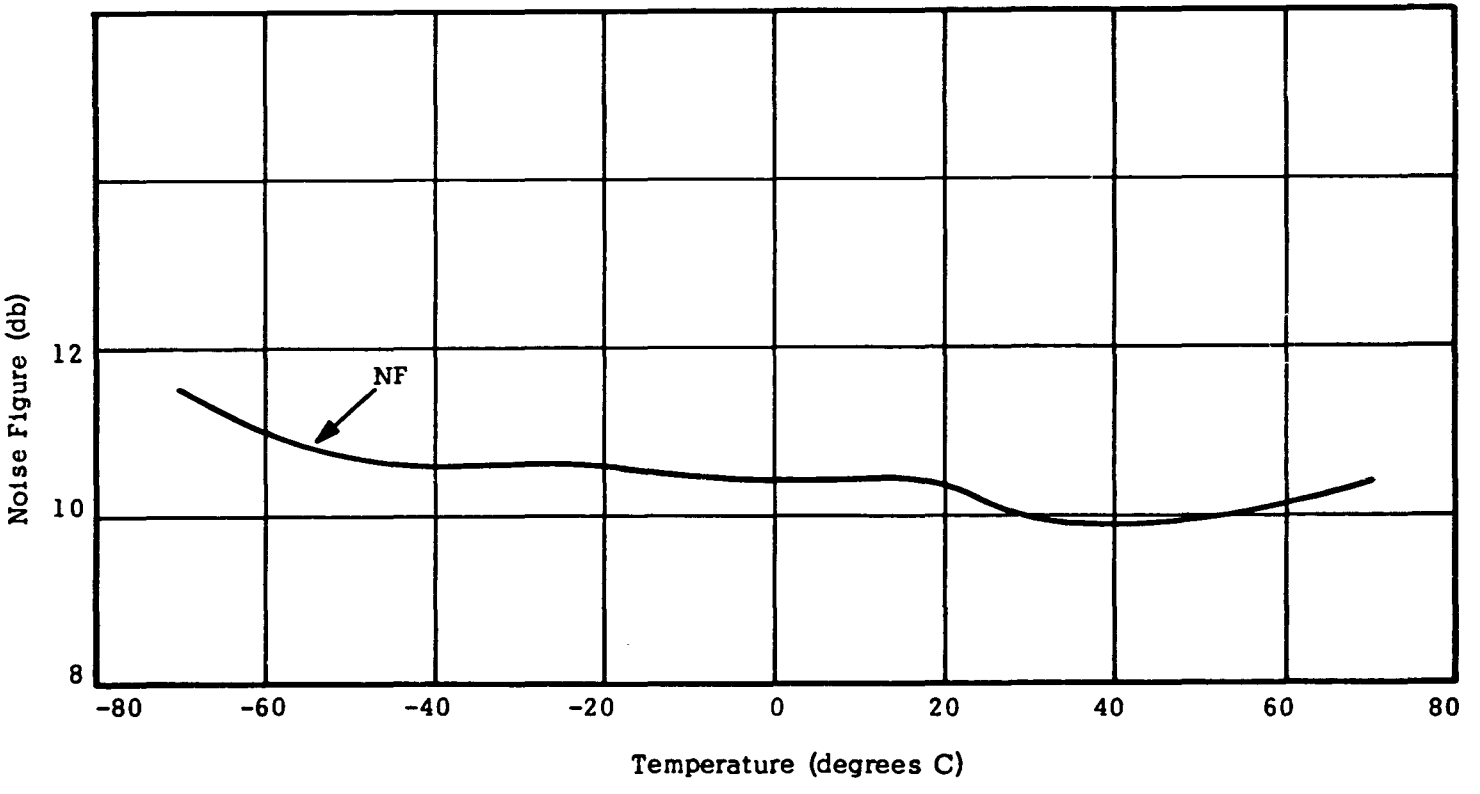

Fig. 2. Temperature Performance, M2105, Serial 218.
(Frequency = 9.0 Gc)

ENVIRONMENTAL TEST DATA
M2112, Serial 44

1. TEMPERATURE AND ALTITUDE*

Test	Temperature		
	Ambient	-55C	55C
Helix Current (μa)	10	500	400
Noise Figure (db)	10.4	11.6	10.5
Small-Signal Gain (db)	39.7	36.7	39.5
Saturated Power Out (dmb)	17.7	14.4	17.4
Altitude (ft)	50,000	50,000	50,000

*Data taken for operation at 6.0 Gc.

2. VIBRATION

3-Axes, Operating		
5-63 cps	0.050 inch, DA	AM less than 1 db
63-2000 cps	10 g	AM less than 1 db

3. SHOCK

3-Axes, Nonoperating		
20 g	11 ± 1 milliseconds	OK

Fig. 3 Environmental Test Data, M2112, Serial 44.

ENVIRONMENTAL TEST DATA
M2112, Serial 55

1. TEMPERATURE AND ALTITUDE*

Test	Temperature			
	Ambient	-60C	74C	Ambient
Helix Current (μa)	140	440	200	120
Noise Figure (db)	10.4	12.8	11.4	10.4
Small-Signal Gain (db)	37.5	37.3	37.9	37.5
Saturated Power Out (dbm)	14.2	12.2	14.5	14.2
Altitude (ft)	50,000	50,000	50,000	50,000

*Data taken for operation at 6.0 Gc.

2. VIBRATION

3-Axes, Operating		
5-63 cps	0.050 inch DA	AM less than 0.3 db
63-2000 cps	10 g	AM less than 0.3 db

3. SHOCK

3-Axes, Nonoperating		
20 g	11 ± 1 milliseconds	OK

Fig. 4.1 Environmental Test Data, M2112, Serial 55.

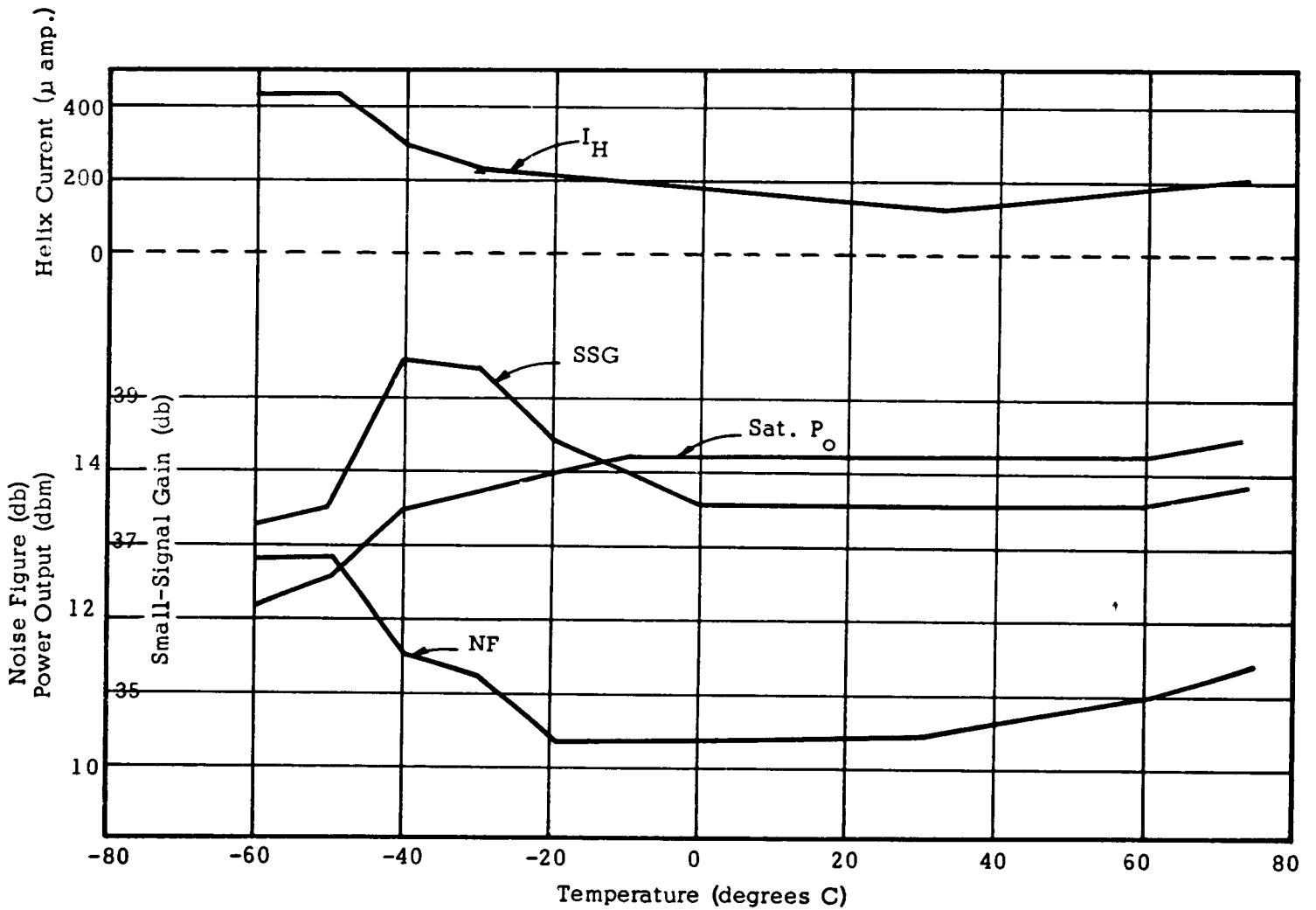

Fig. 4.2 Temperature Test Performance, M2112, Serial 55.
(Frequency = 6.0 Gc)

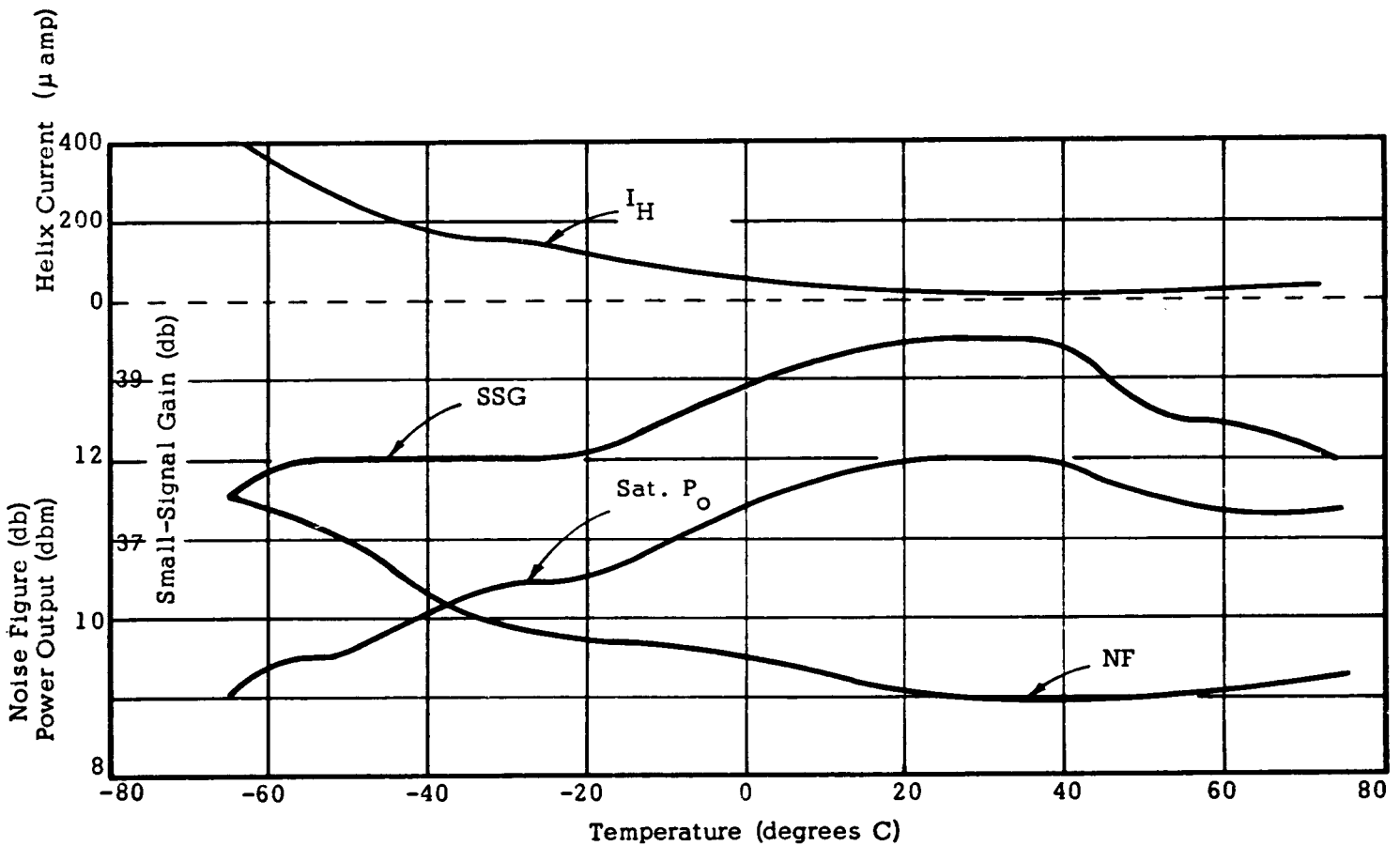

Fig. 5 Temperature Test Performance, M2103, Serial 93.
(Frequency = 3.25 Gc)

3.2 M2108 Life Test

3.2.1 The data for M2108, Serial 77, at the start of the life test and for operation at 837 hours, are given in Fig. 6.

Time (Hours)	Frequency (Gc)	Small-Signal Gain (db)	Power Out (dbm)	Noise Figure (db)
	7.5	26.5	14.8	11.7
0	9.0	24.0	12.8	11.9
	11.0	21.0	9.0	12.6
	7.5	22.5	13.5	13.0
837	9.0	22.5	12.0	12.7
	11.0	20.0	8.0	13.5

Fig. 6. Life Test Data, M2108, Serial 77.

4. CONCLUSIONS

4.1 Analysis of the environmental test data suggests that the temperature, altitude, vibration, and shock requirements of this contract should not only be possible to meet, but could well be exceeded during the performance of this contract. The major unknown factors at this time are the humidity and salt spray performances of the improved package designs.

5. PROGRAM FOR THE NEXT PERIOD

5.1 Environmental Tests

5.1.1 The preliminary humidity and salt spray tests are to be started during the next period and are rescheduled for completion during the following period.

5.2 M2108 Package Environmentalization

5.2.1 The M2108 package environmentalization is behind schedule. It is now expected that the new package parts will be out of the machine shop late in the next period. Assembly of the packages and environmental testing is to be done during the following period.

5.3 M2110 Package Environmentalization

5.3.1 The package parts for the improved M2110 package are now in the machine shop, with delivery to assembly scheduled for late in the next period. Assembly of the packages and environmental testing is to be done during the following period.

5.4 M2109 and M2115 Package Environmentalization

5.4.1 Work on the environmentalization of the M2109 and M2115 packages is scheduled to start during the next period. Scheduled for completion during the period is the redesign of the packages to provide sealing against humidity or salt spray damage.

5.5 Mechanical and Electrical Test Forms

5.5.1 The rough drafts of the mechanical and electrical test forms are to be evaluated during the next period. Final completion of the forms

is rescheduled for the following period.

5.6 Build Ten M2108 Tubes

5.6.1 Fabrication of the ten M2108 tubes has been delayed due to the postponement in the M2108 package environmentalization, and assembly will be rescheduled as soon as the M2108 package environmentalization allows.

5.7 M2108 Life Test

5.7.1 The M2108 life test will reach 1,000 hours on 21 May 1962. The results of this test will be given in the next report.

5.8 Program Schedule

5.8.1 The schedules for NObsr-81227 and the two MEC in-house programs are given in Fig. 7.

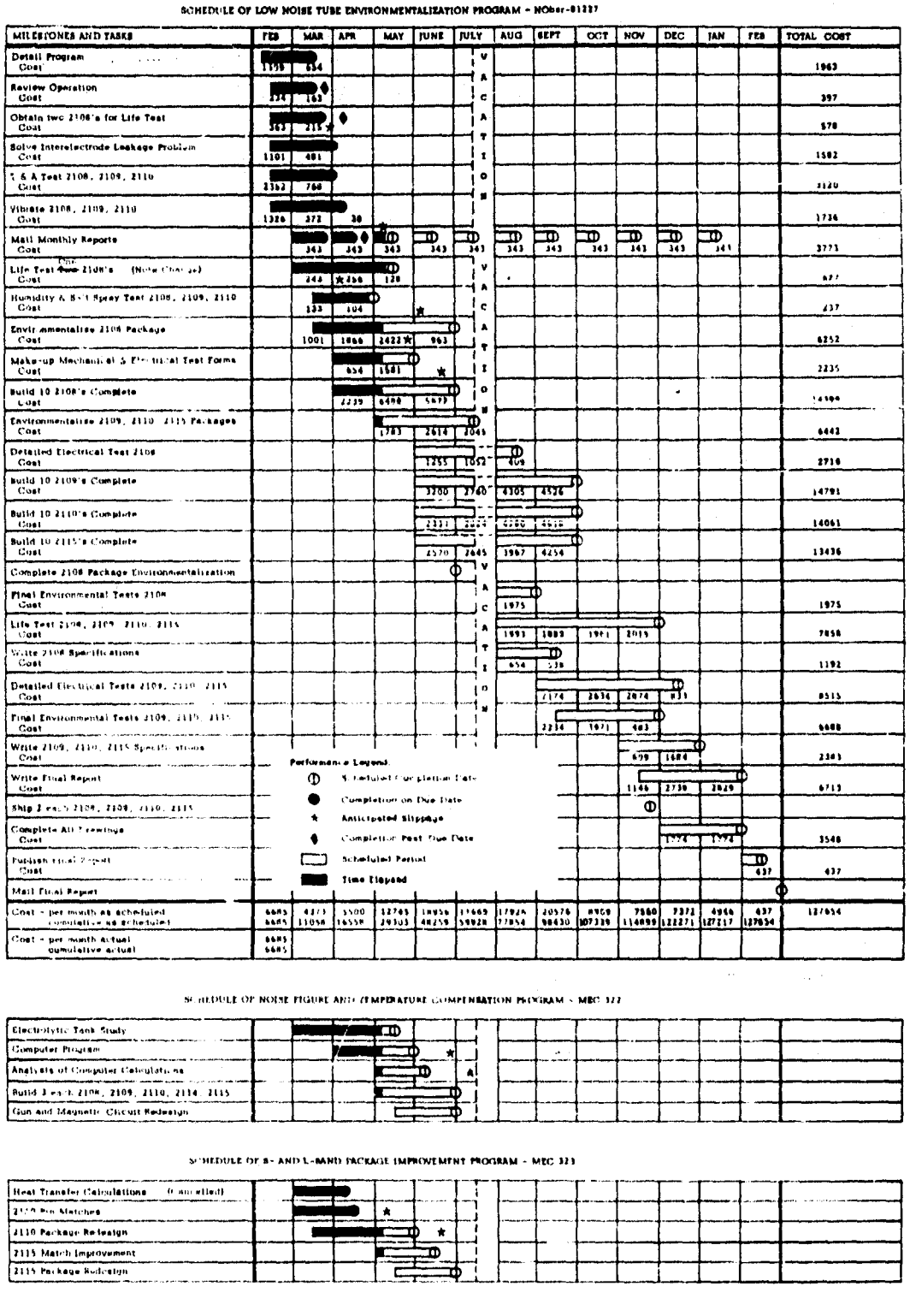

Fig. 7. Program Schedule (Revised 9 May 1962).